

THE BRACONID PARASITES (HYMENOPTERA) OF  
*HELIOTHIS* SPECIES (LEPIDOPTERA: NOCTUIDAE)

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*Abstract.*—A key and a brief diagnosis of each species are given for the braconid parasites of *Heliothis* species in North America. The braconid parasites which have been introduced but which are not established are included. A table listing Old World records of parasites is also given. *Microplitis indicus*, n. sp., is described from India; *Chelonus texanus* is placed in synonymy with *C. insularis*.

The purpose of this paper is to present information on the identity of the braconid parasites of *Heliothis* species as an aid to biological control workers in North America. An illustrated key to the North American species is presented and includes species that have been introduced but not established; a brief diagnosis and discussion are given for each species. Also presented is a list of Old World species that have been recorded from *Heliothis* species.

Most of the introduced parasitic braconids have come from India, but from the list of parasites in the Old World, there are plainly many other possible parasites in southern Europe, Asia and Africa. No parasites have been introduced from South America though several North American parasites also occur in the Neotropical Region. I therefore feel this largely unexplored area offers the best opportunity for further searches for *Heliothis* parasites.

To avoid repetition, I have listed the names and authors of the lepidopteran hosts mentioned in this paper. The spellings for specific names in *Heliothis* are based on a study by Todd (1978).

<i>Chilo plejadellus</i> Zinck.	<i>Heliothis subflexus</i> (Guen.)
<i>Chilo zonellus</i> (Swin.)	<i>Heliothis virescens</i> (F.)
<i>Colias eurythyme</i> BdvI.	<i>Heliothis viriplaca</i> (Huf.)
<i>Coryra cephalonica</i> Stain.	<i>Heliothis zea</i> (Boddie)
<i>Diatraea saccharalis</i> (F.)	<i>Leucania latiuscula</i> (H.-S.)
<i>Elaphria nucicolora</i> (Guen.)	<i>Lineodes integer</i> (Zell.)
<i>Ephestia elutella</i> (Hbn.)	<i>Lineodes interruptus</i> Zell.
<i>Faronta diffusa</i> (Wlkr.)	<i>Loxostege sticticalis</i> (L.)
<i>Feltia subterranea</i> (F.)	<i>Ostrinia nubilalis</i> (Hbn.)
<i>Heliothis armiger</i> (Hbn.)	<i>Papaipema nebris</i> (Guen.)
<i>Heliothis assulta</i> Guen.	<i>Pectinophora gossypiella</i> (Saund.)
<i>Heliothis dipsaceus</i> (L.)	<i>Peridroma saucia</i> (Hbn.)
<i>Heliothis obsoletus</i> (F.)	<i>Phthorimaea operculella</i> (Zell.)
<i>Heliothis ononis</i> (D. & S.)	<i>Pilemia periusalis</i> (Wlkr.)
<i>Heliothis peltiger</i> (D. & S.)	<i>Platyntota stultana</i> (Wlsm.)

<i>Pseudaletia unipuncta</i> (Haw.)	<i>Spodoptera ornithogalli</i> (Guen.)
<i>Semiothisa punctolineata</i> (Pack.)	<i>Spodoptera praefica</i> (Grote)
<i>Spodoptera eridania</i> (Cram.)	<i>Sylepta derogata</i> (F.)
<i>Spodoptera exigua</i> (Hbn.)	<i>Symmetrischema heliopum</i> (Low)
<i>Spodoptera frugiperda</i> (Sm.)	<i>Trichoplusia ni</i> (Hbn.)

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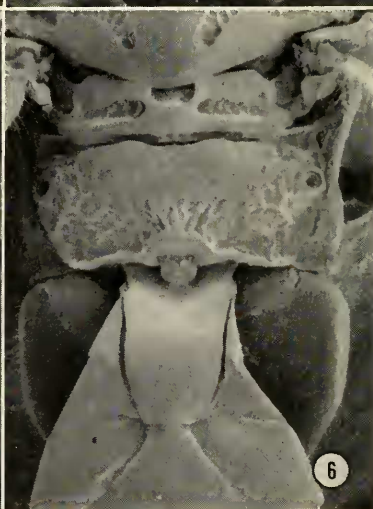
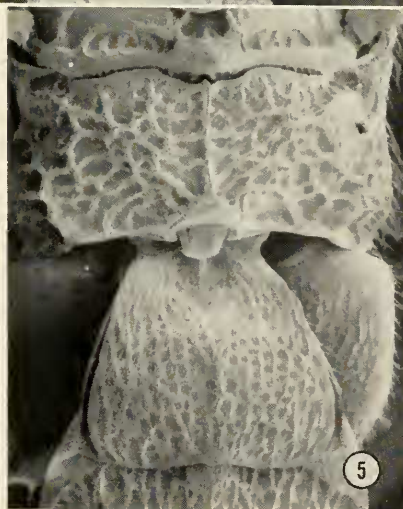
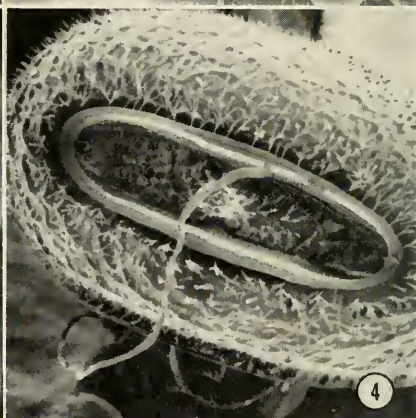
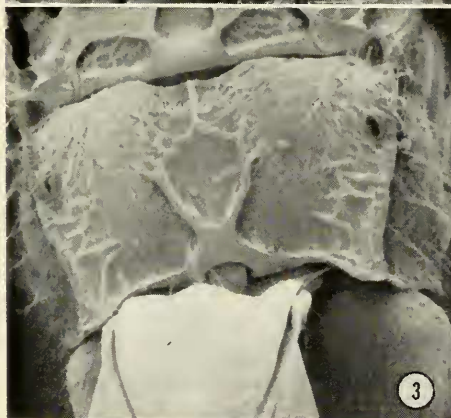
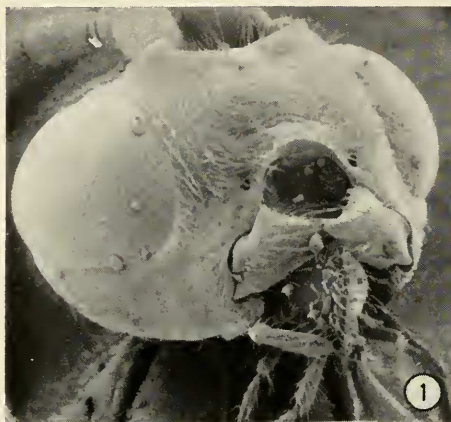
### New World Braconidae Parasitic on *Heliothis* Species

Fifteen species of Braconidae have been recorded as parasites of *Heliothis* in North America. Of the 11 native species, only three—*Cardiochiles nigriceps* Viereck, *Microplitis croceipes* (Cresson), and *Chelonus insularis* Cresson (= *texanus*)—are important in the control of *Heliothis*, and they have been studied extensively. The other native species are only occasional parasites of *Heliothis*, and some of the records need to be confirmed. However, they should perhaps be examined further and are, therefore included in the key. The four introduced species have not become established. They have been included in the key in the event that further studies are made and that they do become established. One of the introduced species is described as new. Brief mention is made for two foreign species which were not introduced against *Heliothis* but for which there is data to indicate possible association with *Heliothis*.

### Key to the North American Braconid Parasites of *Heliothis* Species (Including Those Introduced but not Established)

1. Circular opening present between clypeus and mandibles, labrum concave (as in Fig. 1) 2
- Without a circular opening between clypeus and mandibles, labrum not concave (as in Fig. 2) 4
2. Occipital carina present *Rogas perplexus* Gahan
- Occipital carina absent 3
3. Thorax and abdomen finely granular and dull; antenna more than 20-segmented, the flagellomeres longer than wide
- Bracon platynotae* (Cushman)
- Thorax smooth and shining; abdomen with some reticulation but shining; antenna less than 20-segmented, the flagellomeres about as wide as long *Bracon brevicornis* Wesmael
4. Abdominal terga fused into a carapace 5
- Abdominal terga not fused, with several visible segments 7

5. Antenna of female 16-segmented; carapace of male with transverse opening at apex (Fig. 4) *Chelonus (Microchelonus) heliope* Gupta  
 – Antenna of female more than 20-segmented; carapace of male without such an opening at apex 6
6. Hind femur black; parastigma yellow, apical  $\frac{1}{2}$  of fore wing strongly infuscated (Fig. 11) *Chelonus (Chelonus) narayani* Subba Rao  
 – Hind femur orange at least on apical  $\frac{1}{2}$ ; parastigma black, fore wing uniformly lightly infuscated (Fig. 13)  
*Chelonus (Chelonus) insularis* Cresson
7. Abdomen petiolate 8  
 – Abdomen sessile 9
8. Ventral margins of petiole meeting at base and touching for nearly  $\frac{1}{2}$  length of petiole (Fig. 19) *Meteorus laphygmae* Viereck  
 – Ventral margins of petiole meeting considerably beyond base and touching for only short distance (Fig. 20)  
*Meteorus autographae* Muesebeck
9. Third segment of radius in fore wing distinct and strongly recurved; 2nd segment of radius longer than 1st; fore wing with 3 cubital cells, 2nd longer than wide (Fig. 12) *Cardiochiles nigriceps* Viereck  
 – Third segment of radius absent or weakly sclerotized and straight; 2nd segment not longer than 1st if present; fore wing with 2 or 3 cubital cells, if with 3, then 2nd a small areolet and not longer than wide 10
10. Second cubital cell of fore wing a small areolet (as in Fig. 16) 11  
 – Second cubital cell absent (as in Fig. 17) 13
11. Vertex, temples, and mesonotum smooth and shining; hind femur short and stout, not more than  $3\times$  as long as greatest width  
*Microplitis croceipes* (Cresson)  
 – Vertex, temples, and mesonotum finely punctate and dull; hind femur slender, more than  $3\times$  as long as wide 12
12. Tegula and abdominal terga 1–4 yellow in female, tegula of male yellow *Microplitis indica*, new species  
 – Tegula and abdominal terga of female and male brown or black  
*Microplitis melianae* Viereck
13. Ovipositor long, about as long as abdomen; areola present on propodeum (Fig. 3); stigma clear medially; radius longer than intercubitus (Fig. 18) *Apanteles angaleti* Muesebeck  
 – Ovipositor short, shorter than 1st abdominal tergum; propodeum without areola; stigma brown; radius not longer than intercubitus 14
14. First abdominal tergum wider at apex than at base, coarsely rugose (Fig. 5) *Apanteles marginiventris* (Cresson)  
 – First abdominal tergum narrower at apex than at base, smooth and polished (Fig. 6) *Apanteles militaris* (Walsh)



Genus *Apanteles* Foerster

The only key for North American species is Muesebeck (1920). Wilkinson (1928) provides a key to the Indo-Australian species; Nixon (1972, 1973, 1974, 1976), northwestern European species; Telenga (1955), Russian species; Wilkinson (1932a), Ethiopian species.

*Apanteles angaleti* Muesebeck

*Apanteles angaleti* Muesebeck, 1954:61.

*Diagnosis*.—Length of body, 2.5–3.0 mm, ovipositor about 1 mm. Color: Body black, apex of fore femur, fore tibia and tarsus, basal  $\frac{1}{2}$  of mid tibia, mid tarsus, and basal  $\frac{1}{3}$  of hind tibia yellow, wings and veins hyaline, stigma hyaline with brown border, metacarpus brown, legs of male with more extensive dark coloration. Body: Head shallowly punctate and shining; mesonotum shallowly punctate, the punctures confluent along lines where notauli would be if present; scutellum flat, smooth and shining; propodeum rugose with a short median basal carina and areola strongly margined on apical end (Fig. 3); 1st abdominal tergum narrower at apex than at base and strongly punctate on apical  $\frac{1}{2}$ , rest of terga smooth; ovipositor about as long as hind tarsus, hypopygium extending beyond apex of abdomen. Wing: Fore wing venation as in Fig. 18, radius perpendicular to anterior margin of wing and longer than intercubitus.

In Muesebeck's (1920) key to North American *Apanteles*, *angaleti* will run to *epinotae* but is distinguished by the first abdominal tergum being narrowed at the apex and the more distinctly punctate mesonotum. In Wilkinson's (1928) key to the Indo-Australian species, *angaleti* is similar to *araeceri* from Java, Malaya and India but is distinguished by the less densely sculptured mesonotum, slightly shorter ovipositor, and narrower first abdominal tergum.

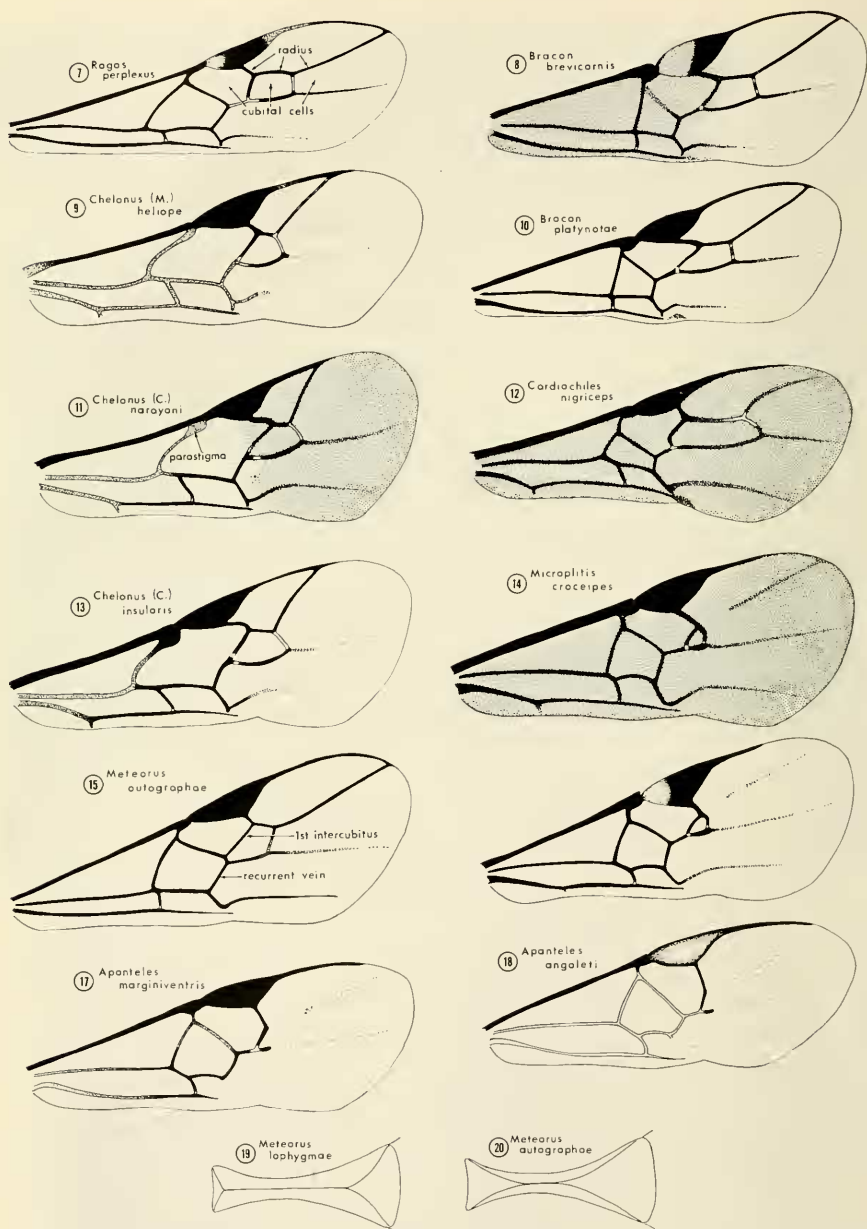
*Distribution*.—India, Sumatra. Introduced into Arizona, Florida, Mississippi, New Jersey, North Carolina, South Carolina, Tennessee, and Texas but not established.

*Hosts*.—*Pectinophora gossypiella*, *Corcyra cephalonica*, *Sylepta derogata*. Also released against *Heliothis virescens* and *H. zea* but not established.

*Additional references* (mostly biology on *Pectinophora gossypiella*).—Narayanan, Subba Rao and Gangrade (1956), Narayanan, Subba Rao and

←

Fig. 1. *Bracon platynotae*, face. Fig. 2. *Chelonus insularis*, face. Fig. 3. *Apanteles angaleti*, propodeum. Fig. 4. *Chelonus heliope*, apex of abdominal carapace. Fig. 5. *Apanteles marginiventris*, propodeum and first abdominal tergum. Fig. 6. *Apanteles militaris*, propodeum and first abdominal tergum.



Figs. 7-18. Wings of *Heliiothis* parasites (stippling indicates shading only, wing hairs not indicated). Figs. 19-20. Ventral view of petiole in *Meteorus* spp.

Kaur (1959), Subba Rao and Gopinath (1961), Narayanan, Subba Rao and Thontadaraya (1962).

*Comments.*—This species was introduced into the United States as a possible biological control agent against both *Heliothis* spp. and *Pectinophora gossypiella*, but it did not become established on either pest. Nevertheless it appears to prefer the pink bollworm. More laboratory tests should be made to establish its use against *Heliothis*.

*Apanteles marginiventris* (Cresson)

*Microgaster marginiventris* Cresson, 1865:67.

*Apanteles grenadensis* Ashmead, 1900:278.

*Apanteles laphygmae* Ashmead, 1901:36. Nomen nudum.

*Apanteles (Protapanteles) harnedi* Viereck, 1912b:580.

*Diagnosis.*—Length of body, 2.0–2.5 mm. Color: Head and thorax black, antennal flagellum dark brown, scape yellow basally, tegula yellow, abdomen varying from entirely black to entirely orange, legs yellow, hind coxa often black, wings hyaline, veins brown. Body: Head punctate, dull; mesonotum punctate, dull, punctures confluent along lines of notauli; scutellum punctate; propodeum rugose with distinct median longitudinal carina (Fig. 5); abdominal terga 1–3 strongly rugose, occasionally weakly so on 3rd tergum, 1st tergum broader at apex than at base (Fig. 5); hind coxa punctate; inner spur of hind tibia longer than outer one; ovipositor about as long as last segment of hind tarsus. Wing: Fore wing venation as in Fig. 17.

This species is recognizable by the sculpturing on the abdomen and hind coxa, color, and length of the hind tibial spurs.

*Distribution.*—Eastern United States west to Wisconsin and Texas; Arizona, California. Mexico, West Indies, northern South America, Hawaii.

*Host.*—*Heliothis virescens* and *H. zea* plus numerous other Noctuidae, most often *Spodoptera frugiperda*.

*Additional references* (mostly concerning biology on *Spodoptera frugiperda*).—Luginbill (1928), Vickery (1929), Boling and Pitre (1970).

*Comments.*—This species is most often found as a parasite of the fall armyworm. It is frequently reared from *Heliothis* spp., but its significance in control is not well established.

*Apanteles militaris* (Walsh)

*Microgaster militaris* Walsh, 1861:369.

*Diagnosis.*—Length of body, 1.75–2.50 mm. Color: Body black, antenna brown, tegula yellow, abdomen light brown ventrally at base and oc-

asionally laterally on terga 1 and 2, legs yellow, wings hyaline, veins brown. Body: Head and mesonotum shiny with scattered shallow punctures; scutellum smooth and shiny with scattered hair pits; propodeum (Fig. 6) finely rugose without median carina; abdomen smooth and polished, 1st tergum (Fig. 6) long and narrow, apex narrower than base; ovipositor barely exerted. Wing: Radius of fore wing perpendicular to anterior margin of wing and slightly shorter than intercubitus.

This species is easily distinguished by the narrow first abdominal tergum, smooth abdominal terga, and yellow legs.

*Distribution.*—North America, Puerto Rico, Argentina.

*Hosts.*—*Pseudaletia unipuncta*, *Heliothis zea*, and numerous other Noctuidae.

*Additional references* (concerning biology on *Pseudaletia unipuncta*).—Guppy (1967), Calkins and Sutter (1976).

*Comments.*—This species is a common parasite of the armyworm, and there are only a few records from *Heliothis zea*. It is therefore not considered important in the control of *Heliothis*.

#### Genus *Bracon* Fabricius

Muesebeck's (1925) key to species is the only one available for North America.

#### *Bracon brevicornis* Wesmael

*Bracon brevicornis* Wesmael, 1838:23.

*Habrobracon brevicornis* (Wesmael). Cushman, 1922:122.

*Microbracon brevicornis* (Wesmael). Muesebeck, 1925:33.

*Diagnosis.*—Length of body, 2–3 mm. Color: Mostly black with yellow markings on head, prothorax, mesonotum, and venter of abdomen, abdomen occasionally entirely yellow, legs brown with coxae black, wings infuscate on basal  $\frac{1}{2}$ . Body: Vertex and frons granular, rest of head smooth; thorax smooth and shining; abdomen finely granular and shining; antenna 16- to 19-segmented in female, 20- to 27-segmented in male; circular opening present between clypeus and mandibles (as in Fig. 1); occipital carina absent; ovipositor about as long as abdominal terga 2 and 3 combined. Wing: Fore wing venation as in Fig. 8.

*Distribution.*—Europe, Asia, Africa. Introduced into the United States and Canada but not established.

*Hosts.*—This species has a long list of hosts. It was purposely introduced into this country in the 1930's against *Ostrinia nubilalis* and subsequently against *Pectinophora gossypiella*, *Heliothis zea*, and *H. virescens*. No recoveries have been made.



*Comments.*—This species is a common parasite of the European corn borer and does not appear to be important in the control of *Heliothis* spp. There is still some question whether *Bracon brevicornis* and *B. hebetor* are distinct species, but that is beyond the scope of this paper.

*Bracon platynotae* (Cushman)

*Habrobracon platynotae* Cushman, 1914:104.

*Bracon platynotae* (Cushman). Muesebeck and Walkley, 1951:167.

*Diagnosis.*—Length of body, 2–3 mm. Color: Head and thorax black, face marked with yellow; abdomen and legs varying from entirely black to entirely honey yellow, wings dusky on basal  $\frac{1}{2}$ , veins and stigma brown. Body: Entire body granular; ocelli small, ocellular distance about  $2\times$  diameter of lateral ocellus; circular opening present between clypeus and mandibles (Fig. 1); occipital carina absent; antenna 22- to 27-segmented, segments longer than wide; ovipositor about  $\frac{1}{2}$  as long as abdomen. Wing: Fore wing venation as in Fig. 10.

*Distribution.*—Arizona, southern California, Georgia, Louisiana, Texas; Mexico.

*Hosts.*—*Heliothis zea*, *Lineodes integer*, *L. interruptus*, *Pectinophora gossypiella*, *Pilemia periusalis*, *Platynota stultana*.

*Comments.*—This is a common parasite of the pink bollworm and only rarely has been reared from *Heliothis* spp.

*Bracon kirkpatricki* (Wilkinson)

This species is a primary parasite of *Pectinophora gossypiella*, but I have seen one reference to it as a parasite of the bollworm (Bryan et al., 1973). If *kirkpatricki* does attack *Heliothis*, it apparently does so at such a low rate as to be insignificant. Further studies should be made to establish the relationship between *kirkpatricki* and *Heliothis*.

Genus *Cardiochiles* Nees

The North American species of *Cardiochiles* can be identified by Mao's (1949) key. Mao (1945) provides a key to the Mexican species; Fischer (1958), Egyptian species; Telenga (1955), Russian species; De Saeger (1948), Belgian Congo species.

*Cardiochiles nigriceps* Viereck

*Cardiochiles nigriceps* Viereck, 1912b:578.

*Diagnosis.*—Length of body, 6–8 mm. Color: Head and antenna black, thorax with venter and propodeum always black, scutellum and mesonotum

posteriorly always orange, pronotum dorsally, mesonotum anteriorly, mesopleuron dorsally varying from black to orange, abdomen orange, fore and mid legs black, tibiae and tarsi sometimes brown, hind coxa and trochanters black, hind femur orange, hind tibia orange or brown, hind tarsus brown, wings strongly infuscated. Body: Head broad, transverse, temples bulging; body smooth and shining except propodeum which is strongly rugose with distinctly margined diamond-shaped areola in middle; hind femur swollen; ovipositor short and barely exerted. Wing: Fore wing venation as in Fig. 12, radius strongly arched, 1st intercubitus distinctly angulate below middle.

This species is not likely to be confused with other North American species; its body color and angled first intercubitus of the fore wing are distinctive.

*Distribution*.—District of Columbia south to Florida, west to Kansas and Louisiana; Mexico. Also introduced into the Philippines but apparently not established.

*Hosts*.—*Heliothis subflexa*, *H. virescens*. Also recorded on *H. assulta* in the Philippines.

*Additional references*.—Chamberlin and Tenhet (1926), Lewis and Brazel (1966), Vinson and Lewis (1965), Lewis et al. (1967), Lewis and Vinson (1968a, 1968b), Vinson (1968, 1969), Lewis and Vinson (1971), Hays and Vinson (1971), Vinson (1972), Lewis et al. (1972).

*Comments*.—This is the most important and most studied braconid attacking *Heliothis*. However, it seems to be restricted to *H. virescens*. There is only one record of it developing on *H. subflexa* (Lewis et al., 1967). It will attack *H. zea* but will not complete its development.

#### Genus *Chelonus* Panzer

There are no keys to North American species of *Chelonus* (in the strict sense); McComb (1968 (1967)) provides a key to the species of the subgenus *Microchelonus* for North America; De Saeger (1948) provides keys for species of both subgenera in the Belgian Congo.

#### *Chelonus (Microchelonus) heliope* Gupta

*Chelonus heliope* Gupta, 1955:209.

*Chelonus (Microchelonus) heliope* Gupta. McComb, 1968(1967):71.

*Diagnosis*.—Length of body, 3–4 mm. Color: Body black, scape yellow, basal flagellomeres brown, apical ones black, basal  $\frac{1}{3}$  of abdominal carapace yellow, fore and mid legs honey yellow except coxae and last tarsal segment which are black or brown, hind coxa black, hind trochanters brown, hind femur black, hind tibia black on apical and basal  $\frac{1}{3}$  with middle  $\frac{1}{3}$

yellow, hind tarsus yellow except last tarsal segment which is black. Body: Strongly sculptured; antenna of female 16-segmented, male 24- to 26-segmented; propodeum with strong tubercles at apical corners; 1st 3 abdominal terga fused into a strongly sclerotized carapace which encloses rest of abdominal segments, apex of abdominal carapace in male with deep transverse groove and tubercle in center of groove (Fig 4). Wing: Fore wing venation as in Fig. 9.

This species is somewhat similar to *pectinophorae* Cushman and *blackburni* Cameron, both of which have been introduced but not established, but it differs by having all flagellomeres at least slightly broader than long and in having the wing entirely hyaline. It is also similar to the endemic *fulgidus* McComb and *shenefelti* McComb but differs from both in having a shorter malar space which is equal to the basal width of the mandible.

*Distribution.*—India. Introduced into Arizona, Florida, Mississippi, New Jersey, North Carolina, South Carolina, Tennessee, and Texas but not established.

*Hosts.*—*Symmetrischema heliopus*, *Pectinophora gossypiella*, *Corcyra cephalonica* (in laboratory). Also introduced against *Heliothis zea*, *H. virescens*, and *Diatraea saccharalis* but not established.

*Additional references.*—Charpentier (1956, 1958), McGough and Noble (1957), Patel et al. (1958).

*Comments.*—This species was introduced in the United States mainly for control of the pink bollworm, but some introductions were also made against *Heliothis*. It has not been established and appears not to be an important parasite of *Heliothis*.

### *Chelonus (Chelonus) insularis* Cresson

*Chelonus insularis* Cresson, 1865:61.

*Chelonus texanus* Cresson, 1872:179. New synonymy.

*Chelonus texanoides* Viereck, 1905:286. New synonymy.

*Chelonus exogyrus* Viereck, 1905:287. New synonymy.

*Chelonus bipustulatus* Viereck, 1911b:476. New synonymy.

*Diagnosis.*—Length of body, 4.5–5.0 mm. Color: Black, abdominal carapace usually with 2 white lateral spots on basal  $\frac{1}{3}$ , carapace rarely entirely black or entirely orange, fore and mid legs orange except coxae, base of femora and apical tarsal segments which are black, hind coxa black, hind femur usually black, occasionally orange, hind tibia orange with base and apex black, wings lightly infuscated, stigma and parastigma black, veins brown or light brown near base of wing. Body: Entirely, strongly sculptured, sculpture rugose but not regularly areolated; antenna 26- to 32-segmented; propodeum with strong tubercles at apical corners; 1st 3 abdominal terga fused into a rigid dorsal carapace which encloses rest of

abdominal segments, apex of carapace of male without groove or impression. Wing: Fore wing venation as in Fig. 13.

This species is similar to *narayani* but can be distinguished by the black parastigma, mostly orange hind femur, hyaline wings, and white spots at base of the carapace. I have seen the type of *insularis* Cresson and there is no doubt that it is the same as *texanus* Cresson.

*Distribution*.—North America, Central America, South America, West Indies. Introduced into Hawaii and South Africa.

*Hosts (for North America)*.—*Ephestia elutella*, *Feltia subterranea*, *Heliothis zea*, *Loxostege sticticalis*, *Peridroma saucia*, *Spodoptera eridania*, *S. exigua*, *S. frugiperda*, *S. ornithogalli*, *S. praefica*, *Trichoplusia ni*.

*Additional references (selected for Heliothis)*.—Pierce and Holloway (1912), Wolcott (1951 (1948)), Ullyett (1949), Botrell et al. (1968), Vinson (1975).

*Comments*.—This species, which occurs throughout the New World, is one of the common native species of *Heliothis* parasites, though it has been more often studied with *Spodoptera frugiperda*.

#### *Chelonus (Chelonus) narayani* Subba Rao

*Chelonus narayani* Subba Rao, 1955:63.

*Diagnosis*.—Length of body, 3.5–4.5 mm. Color: Black, all coxae, trochanters and femora black except apex of fore and mid femora which are occasionally orange, fore tibia and basitarsus orange, rest of fore tarsus brown, mid tibia brown at apex and base, yellow in middle, mid basitarsus yellow, rest of mid tarsus brown, hind tibia black at apex and base, yellow in middle, hind basitarsus yellow, rest of hind tarsus brown, fore wings hyaline on basal  $\frac{1}{2}$ , strongly infuscate on apical  $\frac{1}{2}$ , stigma black, parastigma yellow, abdominal carapace very rarely with weak orange spots at base. Body: Strongly sculptured, face and thorax appearing areolated; antenna 24- to 29-segmented; propodeum with strong spines at apical corners; 1st 3 abdominal terga fused into rigid dorsal carapace, apex of male carapace without groove or impression. Wing: Fore wing venation as in Fig. 11.

This species is similar to *insularis* but can be distinguished by the yellow parastigma and infuscate apex of the fore wing, the black hind femur, the totally black abdominal carapace, and the more areolated sculpturing of the face and thorax. It is also similar to *iridescens* Cresson but is smaller, has a relatively shorter carapace, and has the sculpturing more areolated on the face and thorax.

*Distribution*.—India. Introduced into Arizona, Florida, Louisiana, Mississippi, New Jersey, North Carolina, Pennsylvania, South Carolina, Tennessee, Texas, and Utah but not established.

*Hosts*.—*Heliothis armiger*, *H. zea*, *Chilo zonellus*, *Corcyra cephalonica* (in laboratory). Also introduced into Texas against *Pectinophora gossypiella*, into Pennsylvania against *Papaipema nebris*, into Louisiana against *Diatraea saccharalis* and *Chilo plejadellus*, and into Utah against *Phthorimaea operculella* but also not established.

*Comments*.—This is apparently a good species on *Heliothis* and more studies should be made to determine its effectiveness in North America.

*Chelonus (Microchelonus) blackburni* Cameron

This species was introduced into the United States against *Pectinophora gossypiella* but did not become established. According to Bryan et al. (1973), this species "could (italics mine) parasitize" *Heliothis zea* and *H. virescens*. Further field studies must be made to determine whether it will attack *Heliothis*.

*Chelonus (Chelonus) gossypii* Viereck

This species is not included in the key. It was described (Viereck, 1912a) from Brazil as a parasite "on cotton worm." If this refers to *Heliothis*, then *gossypii* is a possible additional parasite to be considered.

Genus *Meteorus* Haliday

The only key to North American species is that of Muesebeck (1923); Nixon (1943) provides a key to the Ethiopian species.

*Meteorus autographae* Muesebeck

*Meteorus autographae* Muesebeck, 1923:30.

*Diagnosis*.—Length of body, 4–5 mm. Color: Female usually entirely honey yellow, sometimes mesonotum, propodeum and 1st abdominal segment (petiole) dark brown, male usually honey yellow with vertex, mesonotum, propodeum, and all abdominal terga except the 2nd dark brown, stigma uniformly pale yellow, transparent. Body: Eyes large; ocelli large, ocellocular distance about 2× diameter of lateral ocellus; mesonotal lobes smooth; ventral margins of petiole meeting beyond base of petiole and touching for only a short distance (Fig. 20). Wing: Fore wing venation as in Fig. 15, 1st segment of radius at most  $\frac{1}{2}$  as long as 2nd segment, recurrent vein entering base of 2nd cubital cell.

This species is very similar to *laphygmae* but is distinguished by the ventral margins of the petiole and the wing venation.

*Distribution*.—Newfoundland south to Florida, west to Ontario and Louisiana.

*Hosts*.—Many species of Noctuidae but primarily a parasite of *Spodoptera frugiperda*.

*Comments*.—This is not an important parasite of *Heliothis*. I have seen only one specimen reared from *Heliothis zea*.

*Meteorus laphygmae* Viereck

*Meteorus laphygmae* Viereck, 1913:560.

*Diagnosis*.—Length of body, 3.5–5.0 mm. Color: Entirely honey yellow, rarely petiole with black markings at apex. Body: Eyes large; ocelli large, ocellular distance about equal to diameter of lateral ocellus; mesonotal lobes weakly punctate; ventral margins of petiole meeting at base of petiole and touching for nearly  $\frac{1}{2}$  the length of petiole (Fig. 19). Wing: 1st segment of radius of fore wing nearly as long as 2nd segment, recurrent vein interstitial with 1st intercubitus.

*Distribution*.—Texas and New Mexico south to northern South America; introduced into Hawaii.

*Hosts*.—*Autographa* sp., *Colias eurythene*, *Elaphria nucicolora*, *Feltia subterranea*, *Heliothis zea*, *Leucania latiuscula*, *Peridroma saucia*, *Pseudaletia unipuncta*, *Semiothisa punctolineata*, *Spodoptera eridania*, *S. exigua*, *S. frugiperda*.

*Comments*.—This species is occasionally reared from *Heliothis* species though it has been studied most frequently as a parasite of the fall army-worm.

Genus *Microplitis* Foerster

Muesebeck (1922) provides a key to the North American species; Wilkinson (1930), Indo-Australian species; Telenga (1955), Russian species; Nixon (1970), northwestern European species.

*Microplitis croceipes* (Cresson)

*Microgaster croceipes* Cresson, 1872:183.

*Microplitis nigripennis* Ashmead. In Quaintance and Brues, 1905:122.

*Diagnosis*.—Length of body, 3.5–4.5 mm. Color: Head, antenna, and thorax black, abdomen usually orange, rarely black, legs orange except coxae which are black, wings strongly and entirely infuscated. Body: Very smooth and shining; propodeum coarsely rugose with median longitudinal carina; 1st abdominal tergum weakly punctate along edges; temples bulging beyond eye margins; hind femur short and stout, not more than 3× as long as greatest width; ovipositor barely exerted. Wing: Fore wing venation as in Fig. 14.

This species and *longicaudus* are distinct from all other *Microplitis* in North America by their smooth and shining head and thorax and short and stout hind femur. From *longicaudus* this species is distinguished by the shorter ovipositor and infumated wings.

*Distribution.*—New Jersey south to Georgia, west to Utah and Arizona; Oregon. Probably also occurs in northern Mexico.

*Hosts.*—*Heliothis subflexus*, *H. virescens*, *H. zea*.

*Additional references.*—Bryan et al. (1969), Lewis (1970), Jones and Lewis (1971).

*Comments.*—This is one of the more important parasites of *Heliothis* species. It has not been reared from any hosts other than those listed. D. E. Bryan (personal communication) has indicated that biological data presented by Bryan et al. (1969) and Jones and Lewis (1971) do not agree in all respects with the indication that *croceipes* of the eastern United States may not be the same as the western forms. Further study is needed to clarify this matter.

#### *Microplitis indica* Marsh, new species

*Description.*—Length of body, 2.5 mm. Color: Head including antenna and thorax black, abdominal terga 1–4 in female and 1–3 in male orange, rest black, 1st abdominal tergum of male sometimes darker, legs of female orange except tarsi always and hind coxa occasionally black, legs of male orange except coxae and tarsi which are black, tegula orange, wings evenly infumated, veins brown, stigma brown with yellow spot at basal  $\frac{1}{3}$ . Body: Head distinctly punctate, dull; antenna 18-segmented and longer than body in male; mesonotum distinctly punctate and dull; notauli not impressed and only weakly indicated by confluent punctures along their course; scutellum dull, punctate, scutellar furrow wide and deep with 3–5 carinae; mesopleuron strongly punctate except smooth shining area above the crenulate sternaulus; propodeum strongly rugose with weak indication of median carina; 1st abdominal tergum as long as greatest width, parallel sided for  $\frac{2}{3}$  its length, narrowing on apical  $\frac{1}{3}$ , finely rugose laterally, smooth apically; ovipositor sheaths barely exerted, hypopygium not extending beyond apex of abdomen; hind tibial spurs equal in length. Wing: Fore wing venation as in Fig. 16.

This species is similar to *pallidipes* Szepligeti which occurs in southeast Asia but differs by the darker tarsi and antennae, less distinct notauli, and weakly indicated median carina on the propodeum. It is also similar to *rufiventris* Kokujev that occurs in southern Russia (Uzbek, Turkmen), but it can be distinguished by the black tip of the abdomen and black tarsi. In North America, *indicus* runs to *laticinctus* or *bradleyi* in Muesebeck's (1922) key but is distinguished from *laticinctus* by its less sculptured first

abdominal tergum and black antennae and from *bradleyi* by its orange abdominal terga 1-4. It might also be confused with *melianae* but is distinguished by its yellow tegula, orange abdominal terga 1-4, narrower and more rugose first abdominal tergum, and infumated wings.

*Holotype female*.—Kulu, India; lab. reared; Ship't., no. 5, IX-64; ex *Heliothis* sp. Paratypes, 2♀, 2♂, same data as type. All types deposited in USNM.

*Distribution*.—India.

*Host*.—*Heliothis assulta*.

*Comments*.—This species was originally determined as *Apanteles* sp. and later as *Microplitis* sp. near *pallidipes*. It was reared in laboratories in New Jersey and Georgia but never released.

#### *Microplitis melianae* Viereck

*Microplitis melianae* Viereck, 1911a:185.

*Diagnosis*.—Length of body, 2.5-3.0 mm. Color: Head, thorax and abdomen black, tegula brown, abdominal terga 1 and 2 brown laterally and ventrally, coxae and trochanters black or brown, rest of legs yellow, tarsi brown in male, wings hyaline, stigma with basal ½ yellow, rest brown. Body: Head and thorax coarsely punctate and dull; mesopleuron smooth and shining; propodeum rugose with distinct median carina; abdominal terga smooth and shining, 1st abdominal tergum usually punctate at apex; ovipositor barely exerted.

This species might be confused with *indicus* if that species were to be established in North America, but *melianae* is distinguished by its darker tegula and abdomen, hyaline wings, and smoother abdomen.

*Distribution*.—Illinois, Iowa, Kansas, Michigan, Minnesota, New York, Ohio, Ontario, Tennessee.

*Hosts*.—*Faronta diffusa*, *Heliothis zea*, *Pseudaletia unipuncta*.

*Comments*.—This species is a frequent parasite of the armyworm, but there is at least one record from *Heliothis zea*. It is not considered an important parasite of *Heliothis*.

#### Genus *Rogas* Nees

The only reliable keys to species are Telenga (1941) for Russia, Fahringer (1931) for Europe, and Granger (1949) for Madagascar.

#### *Rogas perplexus* Gahan

*Rogas perplexus* Gahan, 1917:205.

*Diagnosis*.—Length of body, 4-5 mm. Color: Mostly brown with the following parts honey yellow, vertex, orbits around eyes, face occasionally,



Table 1. Records of Old World Braconidae parasitic on *Heliothis* spp.

Parasite Species	Host Species	Locality	Reference
<i>Apanteles difficilis</i>	obsoletus	Russia	Telenga, 1937, 1955
<i>Apanteles kazak</i>	obsoletus	Southern Russia	Telenga, 1955; Bogush, 1957
<i>Apanteles popularis</i>	obsoletus	Southern Russia	Bogush, 1957
<i>Apanteles ruficrus</i>	armiger	India	Beeson & Chatterjee, 1925; Bhatnagar, 1950
	obsoletus	Australia	Wilkinson, 1929
		Fiji	Lever, 1941
		Egypt	Hafez, 1947
		Russia	Telenga, 1955
<i>Apanteles maculitarsis</i>	armiger	South Africa	Parsons, 1940
<i>Bracon simonovi</i>	armiger	Southern Russia	Bogush, 1957
	obsoletus	Southern Russia	Bogush, 1957
<i>Bracon turkestanicus</i> (=hebetor)	obsoletus	Southern Russia	Bogush, 1957
<i>Cardiochiles trimaculatus</i>	armiger	Uganda	Coaker, 1959
<i>Cardiochiles nigricollis</i>	armiger	South Africa	Parsons, 1940
<i>Chelonus curvimaculatus</i>	armiger	South Africa	Parsons, 1940; Coaker, 1959
<i>Chelonus versatilis</i>	obsoletus	Sudan	Wilkinson, 1932b
<i>Meteorus laphygmarum</i>	obsoletus	Sudan	Nixon, 1943
		Uganda	Coaker, 1959
<i>Microplitis demolitor</i>	obsoletus	Australia	Smith, 1945
<i>Microplitis rufiventris</i>	obsoletus	Egypt (intro.)	Hafez, 1951
<i>Microplitis pallidicornis</i>	dipsaceus	Russia, Rumania	Telenga, 1937
	(=viriplacus)	Russia	Telenga, 1937
<i>Rogas aestuosus</i>	peltiger	Russia, Cyprus, Syria	Telenga, 1937, 1941
<i>Rogas dimidiatus</i>	obsoletus	Europe	Bogush, 1959; Stary, 1958
<i>Rogas nocturnus</i>	obsoletus	Southern Russia	Bogush, 1957
<i>Rogas testaceus</i>	obsoletus	Southern Russia	Bogush, 1957; Stary, 1958
<i>Rogas armatus</i>	ononis	Europe	Telenga, 1941; Fahringer, 1932

along lines of notauli on mesonotum, scutellum, apex of 1st abdominal tergum, and all of terga 2 and 3, and all legs; wings hyaline, veins brown, stigma brown with base and apex yellow. Body: Entire body granular; eyes and ocelli large, ocellocular distance about equal to diameter of lateral ocellus; circular opening present between clypeus and mandibles (similar to Fig. 1); occipital carina present; abdomen with median longitudinal carina along terga 1-3; ovipositor barely exerted. Wing: Fore wing venation as in Fig. 7.

*Distribution*.—Arizona, southern California, New Mexico, Texas.

*Hosts*.—*Heliothis zea*, *Peridroma saucia*, *Trichoplusia ni*.

*Additional references*.—Butler (1958), rearing records.

*Comments*.—Pupation of species in this genus takes place within the mummified host larva, which retains its shape. This is an uncommon species and insignificant as a parasite of *Heliothis*.

#### Old World Records of Braconidae Parasitic on *Heliothis* Species

Table 1 lists Braconidae from the Old World that have been recorded as parasites of *Heliothis* species. This is not an exhaustive list of all records that I have seen but represents what I believe to be the most reliable records. In many of the records there is no biological information other than a rearing record. Some of the records are undoubtedly incorrect; others indicate some species are occasional parasites of *Heliothis*. These records are presented to indicate potential species of interest and/or areas where parasites might be collected in the future.

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